BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554

In the Matter of	)	
	)	
Implementation of Section 304 of the Telecommunications Act of 1996	)	CS Docket No. 97-80
	)	
Commercial Availability of Navigation Devices	)	
	)	
Compatibility Between Cable Systems and Consumer Electronics Equipment	)	PP Docket No. 00-67
	)	

To: The Commission

COMMENTS OF THE MULTIMEDIA OVER COAX ALLIANCE

The Multimedia over Coax Alliance ("MoCA®") is an open consortium of technology companies developing specifications for physical layer carriage (PHY) of Ethernet over coaxial cable.[1] MoCA has 55 members, including Multichannel Video Programming Distributors ("MVPD"), consumer electronics and set-top box manufacturers, silicon vendors and network equipment providers.[2]

MoCA is the home entertainment networking technology standard in use by all three MVPD segments in the United States: Cable, Satellite and IPTV.[3] MoCA technology has been adopted by the largest five pay TV service providers in the U.S.,[4] who represent at least 75 percent of U.S. pay television households.

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[1] MoCA refers to both the organization and the technology it develops and promotes.

[2] More information on MoCA is available at www.mocaalliance.org.

[3] *See generally id.* (describing membership and announcements of MoCA deployments by various MVPD operators).

[4] *See* National Cable and Telecommunications Association, *Top 25 Multichannel Video Programming Distributors, available at* http://www.ncta.com/Stats/TopMSOs.aspx (listing total basic video subscriber counts for each of the top 25 MVPD operators as of Dec. 2009).

MoCA technology allows carriage of Ethernet over a coaxial cable PHY layer without interfering with other services (such as satellite signal or cable delivery). It supports 175 Mbit/s[5] net throughput, using the existing coax in-home infrastructure. The MoCA networking technology fully supports Quality of Service (QoS).

We are pleased to be able to provide the Commission with commentary on the proposed changes to the interface requirements in the Fourth Further Notice.[6]

I. OVERVIEW

MoCA specifications describe the physical and electrical characteristics of a technology used for implementing IEEE-802 Ethernet over existing in-home 75-Ohm coaxial cables, such as are typically installed for cable television or direct broadcast satellite ("DBS") service. Locations where televisions are installed generally have an existing coaxial cable outlet that was provided when the home was built or subsequently installed by a service provider. By utilizing the existing cabling in consumers' homes, installation of a bidirectional multimedia home network can be accomplished easily without installing new cables, and certainly without pulling new wires through finished construction.

Furthermore, the specifications are defined in a way that the MoCA digital network can co-exist with existing cable television signals and/or DBS L-Band signals. In this way, a MoCA digital network can be created without new wires and without disturbing existing use of the coaxial cabling.

A. INDUSTRY SUPPORT FOR MOCA

The MoCA technology has been widely adopted with support from device vendors and network operators. As of March 2010, more than 30 million MoCA devices have been shipped.[7]

MVPDs such as Cox and DIRECTV have announced selection and deployment of multi-room DVR using MoCA technology, and Verizon FiOS has been deployed using MoCA for several

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[5] MoCA 1.1 achieves a net throughput of 175 Mbit/s over a 270 Mbit/s PHY rate.

[6] *Implementation of Section 304 of the Telecommunications Act of 1996: Commercial Availability of Navigation Devices; Compatibility Between Cable Systems and Consumer Electronics Equipment,* Fourth Further Notice of Proposed Rulemaking, CS Docket No. 97-80, PP Docket No. 00-67 ("Fourth Further Notice").

[7] Multimedia over Coax Alliance, MoCA Technology Summit at CableCongress, (Mar. 5, 2010), *available at* http://www.mocalliance.org/events/presentations/Tech_Summit_Presentation.pdf at 17.

years with more than three million subscribers.[8] The Alliance boasts numerous chip vendors as members - in fact, Entropic Communications[9] and Broadcom[10] are both shipping in volume.

B. BENEFITS OF MOCA TECHNOLOGY

MoCA technology fills a vital need for in-home entertainment networking, and is more than a general IP networking technology. There are many other technologies which are suited to the general case of data IP connectivity (e.g., IEEE 802.11 "Wi-Fi", IEEE 802.3 10/100 BASE-T Ethernet). The primary benefit of MoCA is to provide reliable delivery of high-throughput, low latency applications such as video and VoIP.

C. INTELLECTUAL PROPERTY CONSIDERATIONS

The MoCA specifications and underlying intellectual property is available on a fair, reasonable and non-discriminatory basis.[11] Any silicon vendor may develop MoCA-compliant products under fair, reasonable and nondiscriminatory terms.[12] Silicon implementations of MoCA technology are available.[13] Manufacturers of televisions, set-top boxes, network attached storage (NAS) devices, broadband home routers, Ethernet to coax bridges, Blu-ray players, etc. have access to MoCA silicon on the open market.[14]

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[8] *See, e.g.,* Press Release, Cisco, Cox Launches Whole Home DVR Service With Cisco Set-Tops (May 10, 2010), *available at* http://newsroom.cisco.com/dlls/2010/prod_051010c.html; Press Release, Entropic Communications, Entropic Communications' Silicon Selected by DIRECTV for Home Networking Deployments (Jan. 25, 2010), *available at* http://ir.entropic.com/releasedetail.cfm?ReleaseID=439986; Press Release, VerizonCommunications, Inc., Next-Generation Home Gateways Will Leverage Verizon FiOS Capacities, Enable Dynamic Networked Services Inside the Home (July 23, 2008), *available at* http://newscenter.verizon.com/press-releases/verizon/2008/next-generation-home-gateways.html.

[9] *See* Press Release, Entropic Communications, Entropic Communications' Silicon Selected by DIRECTV for Home Networking Deployments (Jan. 25, 2010), *available at* http://ir.entropic.com/releasedetail.cfm?ReleaseID=439986.

[10] *See* Press Release, Broadcom Corporation, Broadcom Extends Its MoCA®-Integrated Product Family with a Low Cost HD Client Set-Top Box SoC Solution (Jan. 5, 2010), *available at* http://www.mocalliance.org/news/prM_100105_Broadcom_Extends_its_MoCA-Integrated_Product_Family_Low_Cost_HD_Client_Set-Top_Box_SOC_Solution.php.

[11] Membership in MoCA provides companies with access to MoCA's intellectual property under reasonable and non-discriminatory (RAND) licensing terms. *See* Press Release, MoCA Alliance, ST Microelectronics, Conexant and Broadlight Join Moca (May 3, 2006); *see also* MoCA Contributor Agreement, *available at* http://www.mocalliance.org/join/contributor_agreement_download_request.php.

[12] *Id.*

[13] *Supra* notes 9, 10.

[14] *Id.*

D. FUTURE DEVELOPMENTS FOR MOCA TECHNOLOGY

On June 15, 2010, MoCA will announce ratification of MoCA 2.0.[15] This new generation will be both interoperable with existing MoCA deployments, and introduce a variety of improvements including better throughput, coverage and latency, and improved energy saving modes.

II. INTERFACE REQUIREMENTS

In the Fourth Further Notice, the Commission concludes that previous commentators on IEEE-1394 waiver requests made "compelling cases that IP connectivity will provide consumers with the functionality that the IEEE-1394 interface requirement was intended to provide, such as home networking"[16] The Commission has tentatively concluded that allowing manufacturers greater choice will serve the public interest, and will enable connectivity between set-top boxes and IP devices in consumers' homes.[17]

The Commission also proposes modifying section 76.640 of the rules to allow "Ethernet, USB 3.0, or Wi-Fi connectivity" as alternatives to the existing IEEE-1394 output requirement.[18] However, specifying specific physical layer interfaces ("PHY") limits innovation by capping interoperability, performance and standards at the specific point(s) defined for those physical interfaces. Moreover, standards evolve – for example, MoCA 2.0 technology will be an enhancement and improvement over MoCA 1.1, but MoCA 1.1 deployments will continue to perform as designed in the presence of MoCA 2.0 nodes– and if particular PHY are specified, the Commission risks limiting innovation and progress in home video networking.

A. SPECIAL REQUIREMENTS FOR VIDEO OVER IP

The IEEE-1394 interface was intended to be an interface between set-top boxes and recording or playback devices that carries video content. The Commission's proposal to add

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[15] Press Release, MoCA Alliance (June 15, 2010), *available at* http://www.mocalliance.org/news/mocarelease.php (announcing MoCA 2.0).

[16] Fourth Further Notice at ¶ 19.

[17] *Id.*

[18] *Id.* at¶19, App. A (amending § 76.640(b)(4)(ii)).

additional interfaces requires that the additional interfaces be capable of carrying video, particularly over IP. An IP network capable of carrying video streams must meet several performance needs:

There must be sufficient throughput to carry the video streams over the network. An IP network, such as we envision would be deployed in homes, and that the Commission is enabling by adding interfaces, should be capable of carrying several HD streams; home video networks should be capable of simultaneously serving several televisions with several sources.

Compressed video decoders require that the compressed data for each video frame be available in the device at the correct time. In addition to having sufficient throughput to carry the video bitstream (in aggregate), the network must be capable of delivering the data without significant delay ("latency"). It is generally accepted that network latency for video applications must be less than 10 milliseconds. This is necessary so that the memory buffers in receivers are sufficient for playback.

Similarly, the data for a video stream must all arrive with similar latency so as to minimize differences in data reception over time. Variation in latency ("jitter") must be minimized for desired operation; buffers would need to be large (and costly) to counteract excessive network jitter.

Compressed video relies upon transmitting only picture data that has changed from a previous or future picture. As a result, many subsequent video frames are composed from information in one video frame. When network errors occur, they generally persist for many frame times due to the cascade that occurs when the reference has errors. Therefore, home video networks need low packet error rates ("PER"). MoCA has found that $PER \leq 10^{-5}$ is necessary for acceptable performance.[19]

It is also very important that existing home infrastructure supports sufficient bandwidth for video networking. Different technologies that utilize existing infrastructure have varying rates of success in achieving sufficient throughput in the vast majority of cases. One of the goals in developing MoCA was to assure that the vast majority of existing infrastructure is capable of

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[19] This indicates that one packet in $\frac{1}{10^{-5}}$ packets has an error, or 0.001% of packets have an error.

operating with high throughput. For acceptable deployment, more than 95% of existing infrastructure outlets should achieve high (> 100 Mbit/s) throughput rates, and should not significantly degrade performance of the network.

And finally, home video networks need to support QoS. This is necessary to allocate resources to devices on the home video network. Home networks have typically been designed to support best effort data transmission, with dropped or lost packets being retransmitted in the event of network interruptions. However, real-time services such as video or VoIP cannot rely on lost packets being retransmitted. A single stream of video may have dedicated throughput capacity using priority-based QoS schemes. Another way of enabling delivery of multiple streams is by using parameterized QoS schemes and time-slot coordination.

B. MOCA MEETS OR EXCEEDS THE SPECIAL REQUIREMENTS FOR VIDEO OVER IP

MoCA has approximately twice as much throughput as 100-BASE-TX ("Fast Ethernet").[20] MoCA 1.1 has an effective throughput rate of 170 Mbit/s, which (for reference) is nearly twice as much throughput as 100-BASE-TX.[21] MoCA 2.0 will enable higher throughput rates.

Jitter and latency are minimized on a MoCA network. In contrast to, e.g., Fast Ethernet, a MoCA network has a fully scheduled MAC, yielding no collisions. As a result, average latency on a MoCA 1.1 network is 3.5 milliseconds, increasing to five milliseconds when more than eight nodes are connected.

Similarly, packet error rate is minimized on a MoCA network by using a Reed-Solomon forward error correction technique. This allows receivers to correct transmission errors directly, without resorting to retransmission (which adds jitter and delay and decreases throughput).

MoCA conducted a field study of 246 homes in more than 120 ZIP code areas to determine the proportion of home infrastructure that is able to support sufficient network performance to

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[20] For reference, HD video streams consume between 5 and 20 Mbit/s (MPEG-4 HD typically requires at least 5 Mbit/s, and an MPEG-2 ATSC transport stream is 19.39 Mbit/s).

[21] *See* Institute for Electrical and Electronic Engineers, *IEEE Standard for information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements: Part 3: Carrier sense multiple access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications,* IEEE Std 802.3-2008 (Dec. 26, 2008), describing IEEE-802.3u "Fast Ethernet" as 100 Mbit/s. Fast Ethernet signaling is reasonably efficient, yielding an effective throughput of perhaps 85% of the physical transmission rate, or 85 Mbit/s.

make an acceptable home video network. We found that for MoCA 1.0, 97% of all paths in all homes studied were capable of supporting more than 100 Mbit/s data rates.[22] Further investigation showed that the remaining 3% were able to support more than 95 Mbit/s on every path with simple remediation.[23]

MoCA includes support for prioritized QoS and parameterized QoS.[24] Prioritized QoS supports differentiated service for video, voice and gaming applications. Parameterized QoS ("PQoS") supports bandwidth reservations per flow and admission control. These features allow for the network bandwidth to be effectively and efficiently utilized for multiple simultaneous high throughput, impairment-sensitive applications like video and VoIP.

III. CONCLUSION

Specifying particular interfaces can inhibit future innovation. Consumer entertainments interfaces change and evolve over time as new features, products and needs develop. If the Commission chooses to identify specific interfaces, it would be in the public interest for the interfaces identified to include MoCA.

MoCA is the most widely adopted and most widely deployed home video networking technology, and MoCA utilizes the most widely installed physical infrastructure (75-Ohm coaxial cable). Furthermore, MoCA provides excellent carriage of video over IP – the task it was designed for.

Respectfully submitted,

/s/

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President, Multimedia over Coax Alliance

June 14, 2010

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[22] Gary Langille, *Taking Coax [Networking] To The Max*, CED MAGAZINE, Jan. 1, 2006, *available at* http://www.cedmagazine.com/taking-coax-networking-to-the.aspx.

[23] *Id.*

[24] Multimedia over Coax Alliance, PQoS – Parameterized Quality of Service: White Paper (Mar. 11, 2008), *available at* http://www.mocalliance.org/industry/white_papers/PQoS_White_Paper.pdf.